REPORT NO. 76-2-14

MAY 1976
5230

INCIDENCE OF THE NANTUCKET PINE TIP MOTH ON SHORTLEAF AND LOBLOLLY PINES IN SEED ORCHARDS TREATED WITH FURADAN®, CYGON®, DI-SYSTON®, AN. FERTILIZERS

U. S. FOREST SERVICE
Pineville, Louisiana

U. S. DEPARTMENT OF AGRICULTURE -- FOREST SERVICE
SOUTHEASTERN AREA, STATE AND PRIVATE FORESTRY
RESOURCE PROTECTION UNIT, FOREST INSECT AND DISEASE MANAGEMENT GROUP

INCIDENCE OF THE NANTUCKET PINE TIP MOTH ON SHORTLEAF AND LOBLOLLY PINES IN SEED ORCHARDS TREATED WITH FURADAN®, CYGON®, DI-SYSTON®, AND FERTILIZERS

by

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3/ Not registered for use in seed orchards

4/ Registered for use in seed orchards

SECT... -

ABSTRACT

INTRODUCTION

GENERAL METHOI

ABSTRACT

Several field tests and operational projects for tip moth control were conducted using Furadan® (carbofuran), Cygon® (dimethoate), and Di-Syston® (disulfoton) on shortleaf and/or loblolly pines during 1974 and 1975. Furadan was tested on shortleaf pines at the Stuart Seed Orchard, Louisiana in 1974 and 1975. In 1975, operational projects using Cygon® on loblolly pines at the Stuart Orchard and Cygon® and Di-Syston® on shortleaf pines at the Ouachita Seed Orchard, Arkansas were monitored. In addition to the above, an evaluation was conducted of the incidence of tip moth damage on heavily fertilized loblolly pines at the Stuart Orchard in 1975.

The field test at Stuart Orchard during 1974 using Furadan® (10 percent granular) on shortleaf pines (4.27 m = 14' tall) once (February) and twice (February and June) showed that rates of 56, 112, and 224 g/2.5 cm (2, 4, and 8 oz/in) d.b.h., applied once gave good protection to tips through September. There were no significant differences among the three rates. Neither 28 g (1 oz) rate was effective (effective = reduction of tip damage < 10 percent). Double applications were not superior to single applications. No residual tip protection was shown by a June 1975 evaluation of test plots, except for the 224 g (applied twice) treatment.

The field test during 1975 at the Stuart Orchard using Furadan® (10 percent granular) at the rates of 112, 224, and 336 g/2.5 cm (4, 8, and 12 oz/in) d.b.h. on shortleaf pines 8.5 m (26 ft) in height showed that only the 336 g treatment gave adequate tip protection from tip moth attack. None of the treatments were effective in protecting conelets from tip moth damage.

Cygon® (3.5 ml/l = 4 pts/100 gal of water) applied operationally in three applications as a drench spray was ineffective in protecting conelets or tips on loblolly pines at the Stuart Orchard, and was only partially effective in protecting shortleaf pine tips at the Ouachita Orchard. The reason for the failures was considered to be the fact that some spray applications were missed.

Di-Syston® (15 percent granular) applied in March 1975 at the rate of 70 g/2.5 cm (2.5 oz/in) d.b.h. was four times more effective than the control in protecting shortleaf pine tips from tip moth attack at the Ouachita Orchard according to an August evaluation; however, protection was reduced to two times the control by October. It, as well as Cygon®, gave some evidence of protecting conelets from tip moth attack. However, significantly more conelets were lost due to other factors on Cygon® treated trees.

The heavy fertilization treatment (109.3 kg/ha = 600#/acre) showed significantly fewer damaged tips (9.3 percent) than the control (31.8 percent).

INTRODUCTION

The Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock), damages shortleaf, *Pinus echinata* Mill., and loblolly pines, *P. taeda* L., in seed orchards throughout the South. Repeated attacks may result in deformation and/or growth loss to young trees (Beal, 1967: Warren and Young, 1972). Seed yield is substantially reduced by tip moths feeding on first year shortleaf pine flowers (Fig. 1) in early spring (Yates and Ebel, 1972) and on vegetative tips of shortleaf and loblolly pines that contain female flower primordia (Fig. 2).

Currently, foliar sprays of Cygon 2E®3/ (dimethoate), Guthion® (azinphosmethyl), and Dylox® (trichlorfon) are registered for tip moth control on ornamental and shade tree pines. However, to achieve maximum effectiveness, these have to be timed to coincide with external shoot migrations of early instar larvae for each generation of the moth, (Yates, 1967; Overgaard and Wallace, 1974) and thorough coverage has to be obtained (Overgaard, et al., 1974).

Granular systemic insecticides registered for Nantucket pine tip moth control on pines are Thimet®10G (phorate 10 percent granular) for seed orchard trees 2.45 m (8 ft) and less in height and Di-Syston® (disulfoton 15 percent granular) for ornamentals.

Furadan® (carbofuran, 10 percent granular) has proved promising for controlling tip moths attacking loblolly pine seedlings (Walstad, 1973), 5- to 6-year-old loblolly pines (Boyd, et al., 1968), and Japanese black pine, *P. thunbergii* Parl. (Kerr and Owebs, 1973); however, it is not registered for these purposes. Furadan® has been evaluated over the past two field seasons for cone and seed protection

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3/ Mention of trade names does not constitute an endorsement by the U. S. Forest Service. Other products containing the same active ingredients may be equally as effective as those mentioned. Also, because a pesticide is shown effective in test results, this does not imply a recommendation for use. All pesticides must be registered by the EPA for a particular use before they can be recommended.

Fig. 1. Nantucket pine tip moth damage to shortleaf pine conelet. Typical tip moth feeding pitch bubble at base of conelet.

Fig. 2. Nantucket pine tip moth damage to shortleaf pine vegetative tips.

by the Southern Seed Orchard Pest Committee.[4/] Registration for coneworm, seedworm, and seedbug control is expected in 1977. Furadan®, a carbamate insecticide, has a slightly lower mamalian oral toxicity and considerably lower dermal toxicity than do Thimet® or Di-Syston®.[5/] There is less likelihood Furadan® will cause death since poisoning symptoms for humans appear long before a lethal dose is received and the chemical is quickly broken down by the body.[6/] With Thimet® and Di-Syston®, symptoms appear only shortly before a lethal dose is received and are not readily metabolized by the body. None of the above-mentioned insecticides have been evaluated for protecting young conelets from tip moth attacks.

During 1974 and 1975, several field tests and operational projects were monitored to determine the effectiveness of Cygon® and Furadan® on shortleaf and loblolly pines in the Stuart Seed Orchard (Kisatchie National Forest, U. S. Forest Service) in Pollock, Louisiana, and Cygon® and Di-Syston® on shortleaf pines in the Ouachita Seed Orchard (Ouachita National Forest, U. S. Forest Service) in Mt. Ida, Arkansas.

4/ This committee is made up of nine representatives: one each from the three southern seed orchard cooperatives (North Carolina, Florida, and Western Gulf), one from states not represented by a cooperative, one from T.V.A., one representing the Universities, one from the Southeastern Forest Experiment Station, U. S. Forest Service; one from the Southeastern Area, State and Private Forestry, U. S. Forest Service; and one from the National Forest System, U.S. Forest Service.

Its objective is to coordinate pesticide testing efforts on a southwide basis in order to obtain registration of insecticides for use on southern seed orchard pests.

5/ Oral L. D. 50 of technical Furadan for rats is 5 mg/kg and the dermal L. D. 50 is 885 mg/kg, while the oral L.D. 50 of technical Thimet® is 1 - 3 mg/kg and the dermal L. D. 50 is 36 mg/kg. Acute oral L. D. 50 of Di-Syston® for rats is about 3.5 mg/kg; dermal L. D. 50 (rat), 192-235 mg/kg.

6/ FMC Product Manual, Furadan®, insecticide, nematicide, December, 1974, Page 5, Effects on man.

The effectiveness of the above-mentioned chemicals was based on the protection of vegetative tips and conelets from tip moth attack.

Additionally, an evaluation was made at the Stuart Orchard on the effects of heavy fertilizer applications on the incidence of tip moth tip- and conelet-attacks on loblolly pines. The term conelet refers to first year female strobili from the time of flower bud through the end of December.

Overall, we wanted to answer the following questions:

1. Are Furadan® granules effective[7/] for preventing tip attack by the Nantucket pine tip moth in shortleaf pine seed orchards?

2. Are tip moths doing enough damage[8/] in seed orchards to warrant a pest management program?

3. Are the current operational control programs in seed orchards effective for tip moth control?

4. Do cultural practices have any effect on the incidence of tip moths?

7/ Reduction of tip and/or flower damage to > 10 percent for the entire season was considered effective control.

8/ Economic thresholds for tip moth damage to seed orchard trees have not been determined; however, for the purposes of this paper, damage to tips and/or flowers > 15 percent was considered sufficient damage to warrant control.

GENERAL METHODS

All treatments in each study were evaluated for Nantucket pine tip moth damage by examining the 20 topmost tips of each sample tree (ramet) and recording the damage.

Numbers of female flower clusters were counted on all treated and control trees, except those in the 1974 Furadan® test. Ten percent, or a minimum of 10 clusters, were tagged and labelled on each tree. Monthly observations were made to determine the causes of conelet damage.

A randomized block design was used on each study and an analysis of variance and Duncan's multiple range test was run for each set of data on each study.

Rubber gloves, rubber boots, approved respirator masks, and coveralls were used while applying insecticides.

SECTION II

FURADAN® TEST

(SHORTLEAF PINE, STUART ORCHARD, 1974

FURADAN® TEST
(Shortleaf Pine, Stuart Orchard, 1974)

OBJECTIVE

The objective of this study was to determine the effectiveness of Furadan® in protecting vegetative tips of young shortleaf pines from tip moth attack. These tips contain the primordia that give rise to flower buds.

METHODS

Tree and study area description

Species: shortleaf
Tree dimensions: 4 to 7 years, 5-30 cm (2 -12") d.b.h., 1.2 - 6 m (4' - 20') tall
Tree spacing: 4.3 x 8.6 m (15' x 30')
Topography: flat
Soil: Ph: 4.5 - 6.0
Texture: Yellowish brown and reddish mottled silty clay
Soil type: Bowie, Beauregard, Muskogee
Plot layout: 10 acres divided into 8 blocks of 11 rows each, with 7 trees in each row. The two end trees in each row and each outside row in each block were used as a buffer. Each of nine treatments were applied to a randomly selected 5-tree row in each block.

Treatments and application techniques

Furadan® Treatments:

A. 28 g/2.5 cm d.b.h. applied once in February
B. 28 g/2.5 cm d.b.h. twice: applied once in February and once in June
C. 56 g/2.5 cm d.b.h. applied once in February
D. 56 g/2.5 cm d.b.h. twice: applied once in February and once in June
E. 112 g/2.5 cm d.b.h. applied once in February
F. 112 g/2.5 cm d.b.h. twice: applied once in February and once in June

G. 224 g/2.5 cm d.b.h. applied once in February
H. 224 g/2.5 cm d.b.h. twice: applied once in February and once in June
I. Control - no treatment

Dates treatments applied: February 20-21 and June 14, 1974.

Sample description:

360 trees (5 trees x 9 treatments x 8 blocks)
7200 tips examined (20 per tree) each observation date
Observation dates: October 1974, June 1975

Application techniques:

During all February applications, the duff was removed from a 46 cm (18") strip around the drip line of each tree. Furadan® was uniformly applied to this area by means of a calibrated measuring cup and scratched into the soil with a fire rake. Bird mortality occurred during February treatments because scratching was not effective in covering all the granules; therefore, June applications were applied to the 46 cm strip as before, but were lightly disked. On February 20, to test for phytotoxic effects, treatments of 950 g (30 oz) and 1400 g (48 oz) of Furadan® per 2.5 cm (1") of tree diameter were applied as above to single shortleaf pines (> 10 cm or 5" d.b.h.) located outside the orchard.

On March 28, numbers of dead Gastropods and Anthropods were counted in a 30 cm^2 ($12"^2$) plot placed randomly on the scratched sod under one tree of each treatment in each of three blocks for a total of 27 plots examined.

The test plots, a 4 ha (10 ac) longleaf orchard south of the test area, a 15 m (50') grass border area, and a wooded area 150 m (500') north of the orchard were examined for dead birds at 9 m (30') intervals on February 22 and 28, March 8, and June 24.

Rainfall data was taken from 1974 and 1975 records of the Catahoula Ranger District Weather Station located approximately one-quarter of a mile from the orchard.

RESULTS

For the October 1974 examinations, all Furadan® treatment means were significantly different from the control ($p > 0.05$) (Fig. 3).

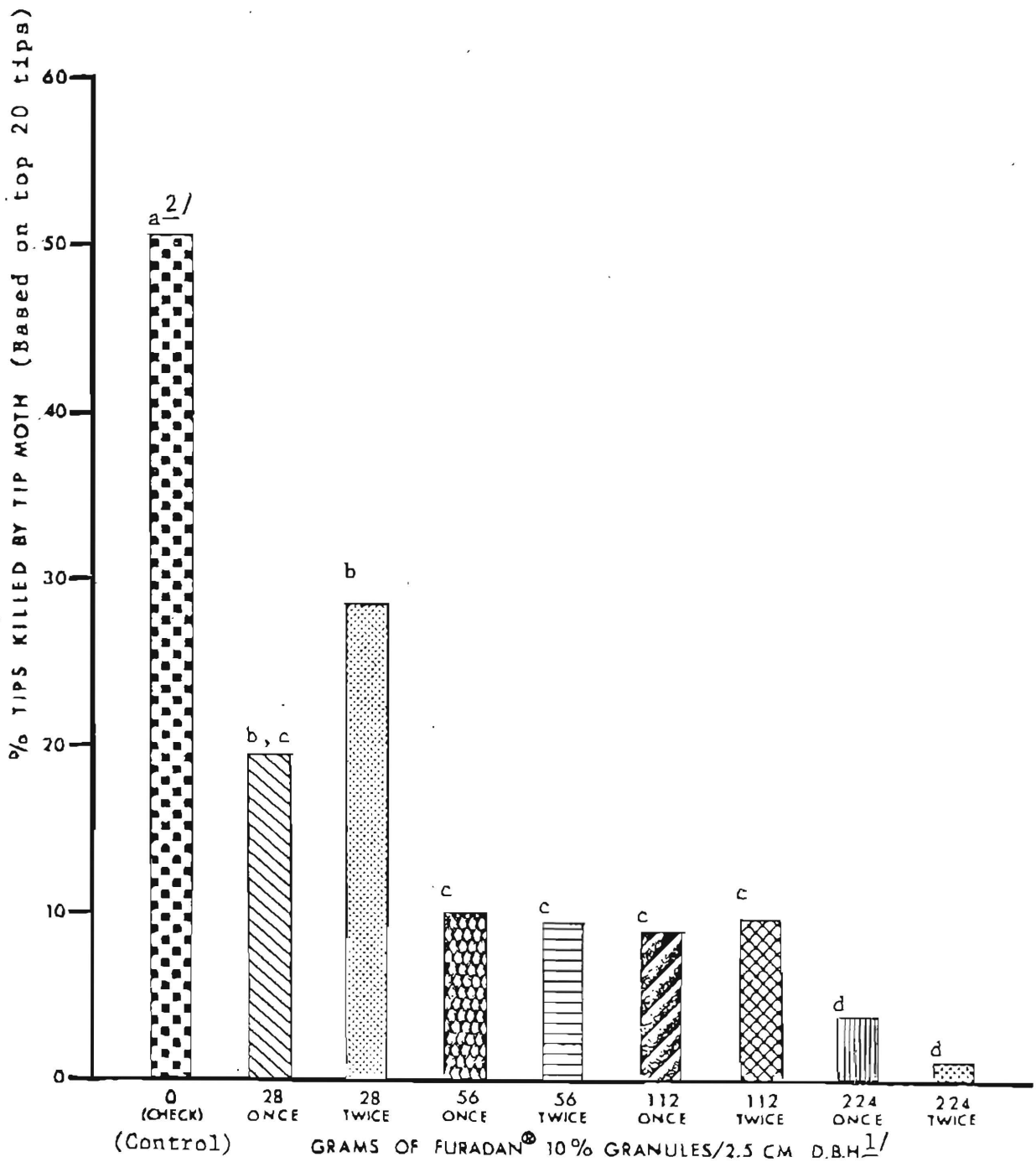

Fig. 3. Effects of Furadan® treatments on percentage of shoots killed by Nantucket Pine Tip Moth, October 1974.

1/ Once: applied Feb. 1974; twice: applied Feb 1974 and June 1974.

2/ Treatments not showing the same letter are significantly different at the 5 percent level of probability by Duncan's new multiple range test.

Treatment means for two applications of a dosage rate were not significantly different from those for one application of the same dosage rate. Although the 28 g (applied once) treatment was significantly better than the control, it did provide effective protection (< 10 percent of the vegetative tips attacked). The 56 g application (applied once) would be the best treatment based on our definition of adequate control (page).

Tips were examined the following year to determine if any carryover protection was provided. June 1975 observations showed a significant difference among treatments (Fig. 4). Control was not considered adequate (< 10 percent of the vegetative tips attacks) for any of the treatments except for the 224 g (applied twice) treatment. Trees having had 28 g applied twice sustained significantly more tip moth damage than all other treatments.

Inspections of the shortleaf pines outside of the study area treated with 950 g and 1400 g of Furadan® granules per 2.5 cm of tree diameter showed severe needle browning in December 1975; however, no tree mortality occurred. No phytotoxic effects were observed on any of the treatment trees in the main study area.

A mean of 0.33 dead Gastropods and Anthropods per 30 cm^2 of ground area was found in control plots, compared to means of 17, 28, 21 and 17 dead organisms found in 28 g, 56 g, 112 g, and 224 g plots, respectively.

Twenty-two dead robins, two sparrows, and one eastern bluebird were found on treatment plots on February 22, 1974. No dead birds were found outside the treatment area on the above date, or inside or outside the treatment area on February 28, March 8, or June 24, 1974. Disking in the Furadan® in June reduced the hazard to birds. No dead mammals were found during any of the inspections.

Rainfall was light to moderate during the period of the test. One day after completion of the February treatments, approximately 1.2 cm of rain was recorded at the Catahoula Ranger District Weather Station 0.4 kl from the orchard. This was probably enough moisture to wash the material into the root zone of the trees. However, rainfall was very light for approximately 30 days after the June treatments (< 2.5 cm [1 in]).

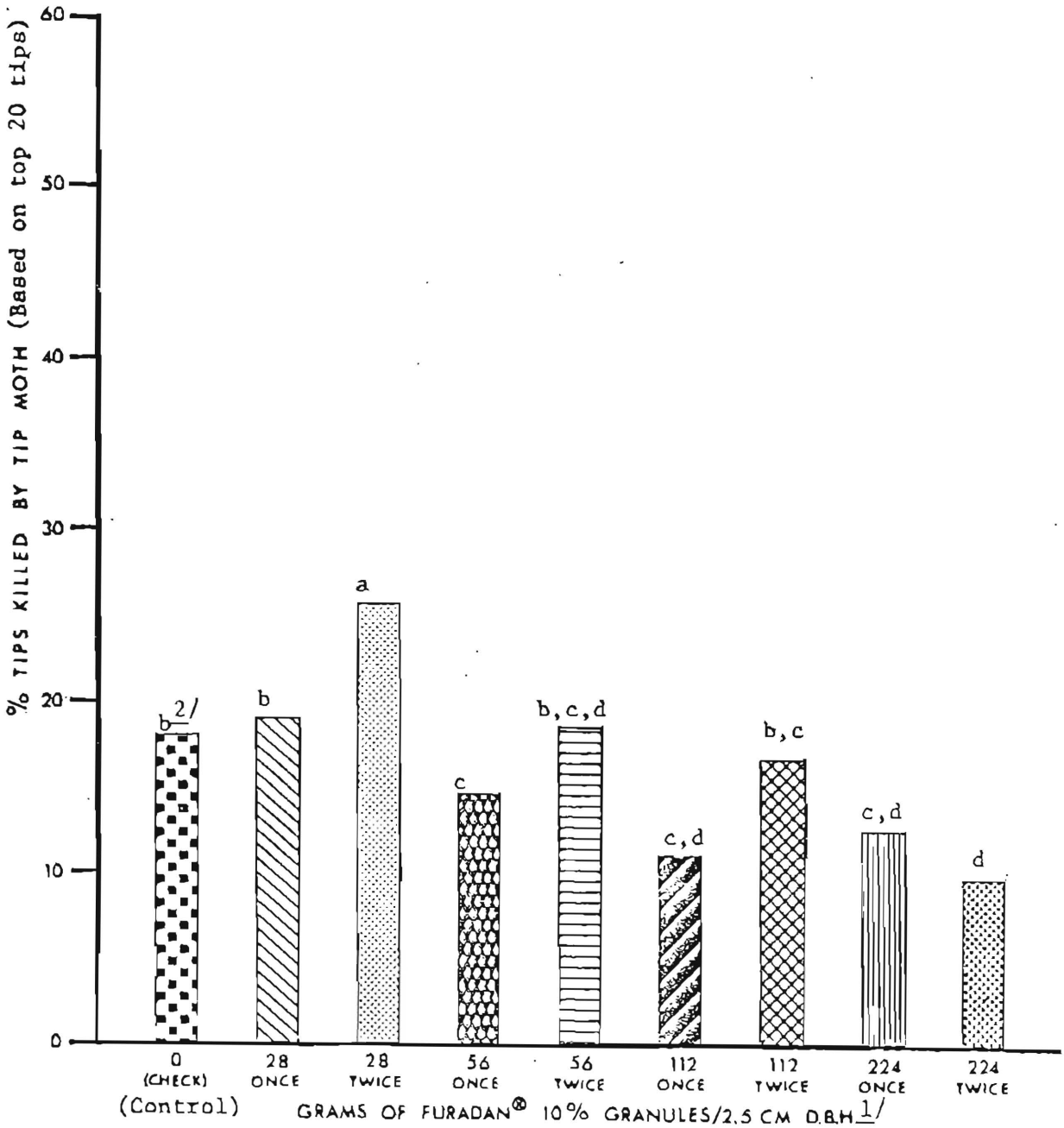

Fig. 4. Effects of Furadan® treatments on percentage of shoots killed by the Nantucket Pine Tip Moth, June 1975.

1/ Once: applied Feb. 1975; twice: applied Feb. 1974 and June 1974.

2/ Treatments not showing the same letter are significantly different at the 5 percent level of probability of Duncan's new multiple range test.

SECTION III

FURADAN® TEST

(SHORTLEAF PINE, STUART ORCHARD, 1975)

FURADAN TEST
(Shortleaf Pine, Stuart Orchard, 1975)

OBJECTIVES

This Furadan® test was part of the 1975 southwide test by the Southern Seed Orchard Pest Committee on control of coneworms, seedworms, and seedbugs attacking second year cones and seeds. We extended this study to evaluate tip moth conelet and vegetative tip mortality occurring from March to September 1975.

METHODS

Tree and study area description:

Species: shortleaf
Tree dimensions: 8 - 10 years, avg. 15 cm (6") d.b.h., 8 m (25') tall
Tree spacing: 4.3 x 8.6 m (15' x 30')
Topography: rolling hills
Soil: Ph: 5.0 - 6.5
Texture: Yellowish brown silty loam
Soil type: Bowie, Beauregard
Plot layout: clones = blocks, buffer-treatment trees were at least 8.6 m (30') apart. Nearest operational spraying was at least 36.6 m (120') from the test area.

Sample description:
Vegetative tips
30 trees (6 clones x 5 treatments x 1 ramet)
600 tips examined (20 per tree) on September 15, 1975
Conelets
18 trees (6 clones x 3 treatments x 1 ramet)
319 clusters containing 722 flowers tagged in March 1975

Treatments and application techniques

A. 112 g (4 oz) of 10 percent granular Furadan®/2.5 cm of d.b.h. disked
B. 224 g (8 oz) of 10 percent granular Furadan®/2.5 cm of d.b.h. disked
C. 336 g (12 oz) of 10 percent granular Furadan®/2.5 cm of d.b.h. disked
D. Control (no Furadan®)
E. Control (no Furadan® disked)

The above Furadan® treatments were evenly spread by hand from the drip line to the trunk on all sides of treatment trees on February 4, 1975. All treatments and one set of control trees were lightly disked.

RESULTS

Conelet damage that could be attributed to tip moth attack accounted for only 0.6 percent of the conelets killed on control (disked) trees, 3.1 percent on control (not disked) trees, and 2.1 percent on the 336 g Furadan® treatment. Furadan® provided no tip moth protection for the conelets.

The 336 g Furadan® treatment showed significantly fewer tips killed by tip moth than all other treatments (Table 1). The 112 and 124 g treatment means were not significantly different from either of the control treatments.

Examinations of treated plots one day and one week after treatment showed no mortality to birds or other wildlife in the area. No phytotoxic effects on treated trees were noted during the duration of the study.

Table 1. Percent[1/] of tips killed by tip moth on 10-year-old shortleaf pines treated with Furadan® (Feb. 4, 1975) at the Stuart Seed Orchard, Pollock, La. (Observed Sept. 16, 1975)

Clone No.	Treatment				
			Furadan® 10 percent granules		
	Control		112 g/2.5 cm d.b.h.	224 g/2.5 cm d.b.h.	336 g/2.5 cm d.b.h.
	not disked	disked			
2	85	95	90	0	0
4	60	60	85	5	30
7	85	65	35	90	5
8	80	70	20	75	20
10	75	65	55	70	0
11	35	15	45	60	0
Mean[2/]	70 a	61 a	68 a	50 a	9 b

1/ Observations based on 20 topmost tips of single ramets of each clone.

2/ Any two means not followed by the same letter are significantly different at the 5 percent probability level by Duncan's new multiple range test.

SECTION IV

CYGON® FERTILIZATION STUDY

(LOBLOLLY PINE, STUART ORCHARD, 1975)

CYGON®, FERTILIZATION STUDY
(Loblolly Pine, Stuart Orchard, 1975)

An impact study was undertaken in cooperation with the Southeastern Forest Experiment Station to develop a life table for loblolly pine female stroboli from early flower (first year) formation to maturity (an 18-month period). For this paper, only tip moth damage to tips and conelets was considered. Trees sprayed with Cygon® and trees heavily fertilized were included in the study.

METHODS

Tree and study area description

Species: loblolly
Tree age and dimensions: 10 years, 12" d.b.h., 6 - 9 m (20' - 30') tall
Tree spacing: 4.3 x 8.6 m (15' x 30')
Topography: rolling hills
Soil:
- Ph: 5.0 - 6.5
- Texture: Yellowish brown silty loam
- Soil type: Bowie and Beauregard

Plot layout: clones = blocks, buffer - check and fertilizer ramets were at least 36.6 m (120') from the nearest Cygon sprayed trees.

Sample description:
- 24 trees (2 ramets x 4 clones x 3 treatments)
- 480 tips examined (20 per ramet) on Sept. 15, 1975
- 259 clusters containing 716 flowers tagged in March 1975

Treatments and application techniques

A. Cygon®2E as a drench spray at rate of 3.5 ml/l (4 pts/100 gal) of water applied May 19, July 15, and August 20
B. Fertilizer - The fertilized area had been treated with 109.3 kg/ha (600 lbs/acre) of 12-12-12 fertilizer in March or April from 1972 to 1975. The check and Cygon® treated areas had also been fertilized with 52.6 kg/ha (285 lbs/acre) of 12-12-12 in April 1975 and 93 kg/ha (500 lbs/acre) in August 1975. No prior fertilization had been done to the latter two areas.

RESULTS

One percent of the conelets were found damaged by the Nantucket pine tip moth on Cygon® treated and control trees and 2 percent on the fertilized trees; however, these differences were not significant. This is the first recorded damage by tip moth to loblolly pine conelets in Louisiana. Yates recently observed tip moth damage to loblolly pine conelets in Georgia (personal communication).

The heavy fertilization treatment showed significantly fewer damaged tips (9.3 percent) than the control (31.8 percent) or the Cygon® (39.4 percent) treatments ($p > 0.05$). Check and Cygon® treatment means were not significantly different (Table 2).

Table 2. Mean percent[1] of tips killed by tip moths on 10-year-old loblolly pines treated with Cygon® and fertilizer at the Stuart Orchard, Pollock, La. (Observed Sept. 15, 1975)

Clone No.	Treatments		
	Light Fertilization[3]		Heavy Fertilization[4]
	Cygon® [2]	Control	
21	40.0	32.5	10.0
9	32.5	27.5	15.0
7	50.0	37.5	2.5
5	35.0	30.0	10.0
Mean[5]	39.4 a	31.8 a	9.3 b

1/ Observations based on topmost 20 tips on each of two ramets of each clone.

2/ Cygon® drench spray at rate of 3.5 ml/l (4 pints/100 gals) water (Applied May 19, July 15, and Aug. 20).

3/ 52.6 kg/ha (285 #/acre) 12-12-12 fertilizer applied in April 1974 and 93 kg/ha (500#/acre) in August 1975.

4/ Approximately 109.3 kg/ha (600#/acre) of 12-12-12 fertilizer applied in the months of March or April during 1972 to 1975.

5/ Any two means not followed by the same letter are significantly different at the 5 percent probability level by Duncan's new multiple range test.

SECTION V

LYGUS, DI-SYSTON TEST

(SHORTLEAF PINE, OUACHITA ORCHARD, 1975

CYGON®, DI-SYSTON®
(Shortleaf Pine, Ouachita Orchard, 1975)

OBJECTIVE

The objective of this test was to evaluate the effectiveness of operational applications of Cygon® and Di-Syston® for protecting vegetative tips and conelets of shortleaf pines from tip moth attack.

METHODS

Tree and study area description

Species: shortleaf
Tree age and dimensions: 6 years, 2.4 m (8' tall), 10 cm (4") d.b.h.
Topography: rolling hills
Soil:
Ph: 4.7 -5.1
Texture: gravelly silt loam to shaley silt loam
Soil type: mixture of Herndon - Goldston
Plot layout: three 4.9 ha (20-acre) plots separated by 36.6 m (120') buffer strips. Clones = blocks.

Sample description:
30 trees (2 ramets x 5 clones x 3 plots)
300 clusters containing 616 conelets tagged on April 9, 1975
600 tips examined on August 1 and October 7, 1975

Treatments and application techniques

A. Di-Syston®(15 percent granular) applied at rate of 70 g/2.5 cm (2.5 oz/1" d.b.h.) by a Herd seeder, Model #I-92 in March 1975. Prior to insecticide application, subsoiling was done at 0.6 m on each side of a row of trees. The area was lightly disked right after the insecticide was applied.
B. Cygon®2E drench spray at the rate of 3.5 ml/l (4 pts/100 gal) water applied with a John Bean Roto-Mist blower, April 30 - May 9, June 12 - 23, and July 31 - August 11.

RESULTS

Treatment means for percent tip moth-killed flowers on the Cygon® and Di-Syston® treated trees were both significantly less than the control ($p > 0.05$) (Table 3). However, significantly more overall flower loss occurred on the Cygon® treatments.

The mean percent tip damage in August and October to both Cygon® and Di-Syston® treated trees was significantly less than that of the control (Table 4). There was no significant difference between means of the Cygon® and Di-Syston® treatments. Both treatments showed good control in August, but protection was considerably reduced by October.

Table 3. Percent[1/] flowers killed from Feb. to June 1975 by tip moth on 6-year-old shortleaf pines treated with Cygon® and Di-Syston® at the Ouachita Orchard, Mt. Ida, Ark. (Feb. to June 1975)

Clone No.	Treatment					
	Cygon®[2/]		Di-Syston®[3/]		Control	
	Killed by tip moth	Missing or killed by unknown unsect	Killed by tip moth	Missing or killed by unknown insect	Killed by tip moth	Missing or killed by unknown insect
19	12.5	58.3	0.0	42.9	5.0	52.6
27	11.5	77.3	3.0	60.0	23.0	40.0
38	0.0	55.0	0.0	41.9	13.0	30.6
43	0.0	54.0	0.0	40.4	21.0	42.0
46	0.0	62.0	3.0	66.7	15.0	35.0
Mean[4/]	4.3	71.7	0.9	52.6	14.9	57.2

1/ Observations based on 10 flower clusters on each of two ramets of each clone.

2/ Cygon® 3.5 ml/l (4 pts/100 gal) of water applied as a drench spray by John Bean Roto Mist, April 30 to May 9, June 12 to 23, and July 31 to August 11.

3/ Di-Syston®(15 percent granules) applied at the rate of 70 g/2.5 cm d.b.h. by a Herd Model I-92 fertilizer spreader in March 1975.

4/ According to Duncan's new multiple range test, the following is probable at the 1 percent level: Cygon® and Di-Syston® treated trees had significantly lower conelet loss due to tip moth, but Cygon® treated trees had significantly greater conelet loss due to other causes.

Table 4. Percent[1/] of tips killed by tip moth on 6-year-old shortleaf pines treated with Cygon® and Di-Syston® at the Ouachita Orchard, Mt. Ida, Ark. (Observed Aug. and Oct. 1975)

Clone No.	Treatment					
	Cygon® [2/]		Di-Syston® [3/]		Control	
	Aug.	Oct.	Aug.	Oct.	Aug.	Oct.
19	10.0	67.5	12.5	47.5	37.5	82.5
27	7.5	25.0	5.0	45.0	35.0	62.5
38	0.0	55.0	0.0	30.0	20.0	70.0
43	5.0	45.0	5.0	20.0	15.0	47.5
46	5.5	32.5	12.5	42.5	40.0	72.5
Means [4/]	5.5	45.0	7.0	37.0	29.5	67.0

1/ Observations based on 20 topmost tips on each of two ramets of each clone.

2/ Cygon®2E at rate of 3.5 ml/l (4 pts/100 gal) of water applied as a drench spray with a John Bean Roto Mist sprayer. Applied April 30 to May 9, June 12 to 23, and July 31 to Aug. 11, 70 g/2.5 cm (2.5 oz/in) d.b.h.

3/ Di-Syston® (15 percent granular) of tree diameter fertilizer spreader--subsoiled prior to application--disked after application. Applied March 15.

4/ According to Duncan's new multiple range test, the following is probable at the 1 percent level: Cygon® and Di-Syston® treated trees had significantly less tips killed by tip moth.

SECTION VI

SUMMARY

DISCUSSION

SUMMARY AND DISCUSSION

What are the answers to the questions presented in the introduction?

1. Are Furadan® granules effective in preventing Nantucket pine tip moth tip attack in shortleaf seed orchards (reduction of damage to < 10 percent tip kill for the entire season)? Yes.

In the 1974 test, Furadan® 10 percent granules applied in February at the rates of 56, 112, and 224 g/2.5 cm (2, 4, and 8 oz/in) d.b.h. gave good protection through September to the topmost 20 vegetative tips of shortleaf pines (average of 4.15 m or 14' tall) from tip moth attack. The 56 g (applied once) rate was as effective as all higher dosage rates; therefore, it should be considered for pilot testing. Double applications (February and June) of all except the 28 g rate were not superior to single applications (February). During this test, no residual tip protection from tip moth attack was obtained through June 1975, except 224 g Furadan® applied twice. During the 1975 Furadan® tests, good tip protection on shortleaf pine (average of 8 m or 25' tall) was obtained only with 336 g/2.5 cm (12 oz/in d.b.h.) applications disked in during February. The reason for this may be that the trees treated in the 1975 test were taller than those treated in 1974. A possible reason why the 112 and 224 g rates during the 1975 tests and double dosage rates during the 1974 tests performed poorly was because many roots may have been cut while disking, thereby inhibiting uptake of the chemicals. Also, lack of rainfall after the second treatment may partially explain why double applications were not any better than single applications.

Since disking may inhibit uptake of Furadan® by roots and the insecticide left on the ground surface is attractive and lethal to birds, an application technique must be developed that can be used to incorporate the granules into the soil without disturbing the roots. This is currently being researched by cooperators working with the Southern Seed Orchard Pest Committee.

Also, tests should be conducted to determine if fall or winter application of Furadan® granules will protect the flower buds from tip moths and other insects.

2. Are tip moths doing enough damage (> 15 percent flower and/or tip damage) in seed orchards to warrant a pest management program? Yes, especially in the shortleaf orchards evaluated.

On shortleaf pines in the 1975 Ouachita evaluation, at least 15 percent of the female conelets were destroyed by tip moths on control trees. Also, in an impact study at the same orchard over a 2-year period (1974-75), tip moths were responsible for the loss of 45 percent of the total cone crop (unpublished data). These insects also destroy vegetative tips which may produce female flowers the following spring. According to the 1974 Stuart shortleaf, the 1975 Stuart shortleaf, the 1975 Stuart loblolly, and the 1975 Ouachita shortleaf damage evaluations, 50 percent, 70 percent, 32 percent, and 60 percent, resectively, of the topmost vegetative tips were destroyed when no treatment was applied.

However, evaluation techniques as part of a pest management system used to predict tip moth population trends or damage levels from year to year or generation to generation are not presently available. Until such techniques are developed, seed orchard managers will have to rely on a spray schedule based on periods of external shoot feeding by larvae or on use of a systemic insecticide as a preventive soil treatment.

3. Are the current operational programs effective (reduction to < 10 percent flower or tip damage)?

No definite conclusion can be drawn based on the erratic results of current evaluations of our operational projects.

The Cygon® treatment was ineffective in protecting the shoots from tip moth damage to loblolly pines at the Stuart Orchard. One reason for this was the excessive rainfall periods when orchard personnel were not able to get spray equipment into the orchard to apply the insecticide during optimum timing periods (when tip moth larvae were feeding on the external portions of shoots). In fact, the first generation of the moth was missed completely. Cygon® was five times more effective than the control in protecting shortleaf pines at the Ouachita Orchard from shoot attack in August, and only 1.5 times as effective in October. Missing the spray application for the last generation was considered the reason for poor protection. The above-mentioned failures in obtaining control of tip moth points to the necessity for proper timing of spray applications for each generation of the moth when applying foliar sprays.

Di-Syston® applied in March 1975 was four times more effective than the control in protecting vegetative shoots of shortleaf pines from tip moth attack at the Ouachita Orchard according to the August

evaluation; however, protection was reduced to two times the control by October. It, as well as Cygon®, gave some evidence of protecting conelets from tip moth attack. However, significantly more conelets were lost due to other factors on Cygon® treated trees. This may indicate phytotoxic effects associated with the spray or that young larvae fed on conelets causing them to abort before the insecticide was applied.

While these evaluations did not entirely answer the question of effectiveness, they did point out the need for monitoring new operational control projects in seed orchards. Monitoring helps to determine if sprays are effective and properly timed, when and how much damage is occurring, if non-target insects and mites are building up in the orchard, and if resistance to insecticides is occurring in the pest population. If desired results are not being obtained, control techniques can be changed, eliminated, or modified to achieve desired results.

For instance, if Cygon® sprays cannot be properly timed due to inability to get equipment into the orchard during certain seasons, a systemic insecticide may need to be used instead. Also, if the orchard's main reason for spraying with Cygon® was protection of the flower crop, Cygon® might as well be eliminated as a control as more flower loss occurred on treated trees than on control trees.

Additionally, if control with a systemic only lasts a portion of the season as did Di-Syston® at the Ouachita Orchard, it may be determined that another application would be necessary in mid-season.

4. Do cultural practices have any effect on the incidence of tip moths? Yes, in this one instance.

Loblolly pines treated the last 4 years with large amounts of fertilizers (600#/acre 12-12-12) had significantly fewer tip moth attacks than pines treated one season with 285#/acre of the above fertilizer.

To our knowledge, this is the first indication of a cultural practice having an influence on an insect population in a pine seed orchard. Additional situation studies must be evaluated to elaborate on this finding and to determine the effects of fertilization and other cultural practices on seed orchard pests.

LITERATURE CITED

Beal, R. H. 1967. Heavy tip moth attacks reduce early growth of loblolly and shortleaf pine. USDA For. Serv. Res. Note SO-54, 3 p.

Boyd, J. P., R. L. Burton, and R. R. Walton. 1968. Control of Nantucket pine tip moth on pines in ornamental or small plantations by systemic insecticides. Okla. State Univ. Agric. Res. Bull. B-661, 39 p.

Kerr, J. W. and J. M. Owebs. 1973. Carbofuran granules for control of the Nantucket pine tip moth in Japanese Black Pine. J. Econ. Ent. 66:1236.

Overgaard, N. A. and H. N. Wallace. 1974. Nantucket pine tip moth control on shortleaf pine at Stuart Orchard, Kisatchie National Forest (1971-1973). USDA For. Serv., S. E. Area, State and Private For., Div. For. Pest Mgt., 6 p.

Overgaard, N. A., L. E. Drake, and H. N. Wallace. 1974. Summary of seed orchard insect evaluations during 1973 by the Alexandria Field Office. USDA For. Serv., S. E. Area, State and Private For., Div. For. Pest Mgt., 4 p.

Walstad, J. D. 1973. Field screening of insecticides for control of insect pests of loblolly pine seedlings. Weyerhaeuser Res. Rept. No. 72-77, 19 p.

Warren, L. O. and J. Young. 1972. Long-term effects of pine tip moth control. Ark. Farm Res. (March-April):4.

Yates, H. O. 1967. Larval migration of *Rhyacionia* spp. on pine shoots (Lepidoptera:Olethreutidae). J. Ga. Ent. Soc. 2:37-41.

Yates, H. O. and B. H. Ebel. 1972. Shortleaf pine conelet loss caused by the Nantucket pine tip moth, *Rhyacionia frustrana* (Lepidoptera:Olethreutidae). Ann. Ent. Soc. Amer. 65:100-4.

ACKNOWLEDGEMENTS

We would like to thank the following people for assistance with these evaluations:

Don Wilmore, Seed Orchard Manager, Stuart Seed Orchard, Kisatchie National Forest
Jim McMahen, Seed Orchard Manager, Ouachita Seed Orchard, Ouachita National Forest
Jim Gates, Tree Improvement Forester, Region 8